CLAIMS

We claim:

1. A method of bonding a chip to a substrate, comprising the steps of:

providing a semiconductor chip having an exposed metal terminating pad thereover, and a separate substrate having a corresponding exposed metal bump thereover;

forming a conducting polymer plug over said exposed metal terminating pad;

forming a conforming interface layer over said conducting polymer plug;

aligning said conducting polymer plug of said semiconductor chip with said corresponding metal bump;

mating said conforming interface layer over said conducting polymer plug with said corresponding metal bump; and

thermally decomposing said conforming interface layer, adhering and permanently attaching said conducting polymer plug of said semiconductor chip with said corresponding metal bump of said separate substrate.

2. The method of claim 1, wherein said conducting polymer plug is from about 1000 to 10,000Å thick.

3. The method of claim 1, wherein said exposed metal terminating pad and said exposed metal bump are comprised of copper.

4. The method of claim 1, wherein said conducting polymer plug is comprised of a material selected from the group consisting of doped polyacetylene, poly (para-phenylene vinylene) (PPV), and polyaniline.

5. The method of claim 1, wherein said conducting polymer plug is a material doped to degeneracy.

6. The method of claim 1, wherein said conforming interface layer is comprised of $Ni(CO)_4$.

7. A method of bonding a chip to a substrate, comprising the steps of:

providing a semiconductor chip having a metal terminating pad thereover, and a separate substrate having a corresponding exposed metal bump thereover;

forming final passivation layer over said metal bump;

forming an opening within said final passivation layer, exposing said metal terminating pad;

forming a conducting polymer plug within said final passivation layer opening and over said exposed metal terminating pad;

forming an interface layer over said conducting polymer plug and said final passivation layer;

removing the excess of said interface layer over said final passivation layer and not over said conducting polymer plug, forming conforming interface layer;

removing said passivation layer from said semiconductor chip;

aligning said conducting polymer plug of said semiconductor chip with said corresponding metal bump;

mating said conforming interface layer over said conducting polymer plug with said corresponding metal bump; and

thermally decomposing said conforming interface layer, adhering and permanently attaching said conducting polymer plug of said semiconductor chip with said corresponding metal bump of said separate substrate.

8. The method of claim 7, wherein said conducting polymer plug is from about 1000 to 10,000Å thick.

9. The method of claim 7, wherein said exposed metal terminating pad and said exposed metal bump are comprised of copper.

10. The method of claim 7, wherein said conducting polymer plug is comprised of a material selected from the group consisting of doped polyacetylene, poly (para-phenylene vinylene) (PPV), and polyaniline.

11. The method of claim 7, wherein said conducting polymer plug is doped to degeneracy.

12. The method of claim 7 wherein said conforming interface layer is comprised of $Ni(CO)_4$.

13. A method of bonding a chip to a substrate, comprising the steps of:

providing a semiconductor chip having a copper terminating pad thereover, and a separate substrate having a corresponding exposed copper bump thereover;

forming final passivation layer over said copper bump;

forming an opening within said final passivation layer, exposing said copper terminating pad;

forming a conducting polymer plug within said final passivation layer opening and over said exposed copper terminating pad; said conducting poly plug being from about 1000 to 10,000Å thick;

forming an interface layer over said conducting polymer plug and said final passivation layer;

removing the excess of said interface layer over said final passivation layer and not over said conducting polymer plug, forming conforming interface layer;

removing said passivation layer from said semiconductor chip;

aligning said conducting polymer plug of said semiconductor chip with said corresponding copper bump;

mating said conforming interface layer over said conducting polymer plug with said corresponding copper bump; and

thermally decomposing said conforming interface layer, adhering and permanently attaching said conducting polymer plug of said semiconductor chip with said corresponding copper bump of said separate substrate.

14. The method of claim 13, wherein said conducting polymer plug is from about 3000 to 6000Å thick.

15. The method of claim 13, wherein said conducting polymer plug is comprised of a material selected from the group consisting of doped polyacetylene, poly (para-phenylene vinylene) (PPV), and polyaniline.

16. The method of claim 13, wherein said conducting polymer plug is doped to degeneracy.

17. The method of claim 13 wherein said conforming interface layer is comprised of $Ni(CO)_4$.

18. A method of forming a $Ni(CO)_4$ layer, comprising the steps of:

providing a substrate within a reaction chamber;

forming a layer of nickel over the substrate; and

introducing CO into the reaction chamber at a temperature of less than 40°C to cause the reaction

$$Ni + 4\,CO \rightarrow Ni(CO)_4$$

to occur whereby the $Ni(CO)_4$ layer is formed.

19. The method of claim 18, wherein the nickel layer is formed by sputtering or electroplating.

20. The method of claim 18, wherein the CO introduced into the reaction chamber is pressurized.

21. The method of claim 18, wherein the nickel layer is formed by sputtering or electroplating; and the CO introduced into the reaction chamber is pressurized.

22. The method of claim 18, wherein the formed $Ni(CO)_4$ layer is maintained below -19°C whereby the formed $Ni(CO)_4$ layer is solid.

23. The method of claim 18, wherein the substrate is a semiconductor substrate.

24. The method of claim 18, wherein the nickel layer is formed by sputtering or electroplating; the CO introduced into the reaction chamber is pressurized; and substrate is a semiconductor substrate.

25. A method of forming a solid $Ni(CO)_4$ layer, comprising the steps of:

providing a substrate within a reaction chamber;

forming a liquid layer of $Ni(CO)_4$ over the substrate at a temperature between -19°C and 40°C; and

then lowering the temperature of the substrate or the reaction chamber below -19°C to form the solid $Ni(CO)_4$ layer.

26. The method of claim 25, wherein the substrate is a semiconductor substrate.

27. A method of patterning a solid $Ni(CO)_4$ layer, comprising the steps of:

providing a substrate having a solid $Ni(CO)_4$ layer formed thereover;

forming a partial chrome photoresist layer over the solid $Ni(CO)_4$ layer; the partial chrome photoresist having a chrome portion and a non-chrome portion;

exposing the partial chrome photoresist layer with radiation that penetrates only the non-chrome portion of the photoresist layer to the underlying solid $Ni(CO)_4$ layer whereby the temperature of the radiation exposed portion of the solid $Ni(CO)_4$ layer is increased to above 40°C so that the radiation exposed portion of the solid $Ni(CO)_4$ layer decomposes so that the solid $Ni(CO)_4$ layer is patterned.

28. The method of claim 27, whereby the solid $Ni(CO)_4$ layer decomposes according to the reaction:

$$Ni(CO)_4 \rightarrow Ni + 4\ CO.$$

29. The method of claim 27, whereby the solid $Ni(CO)_4$ layer has a temperature of less than -19°C.

30. The method of claim 27, whereby the solid $Ni(CO)_4$ layer has a temperature of less than -19°C; and the solid $Ni(CO)_4$ layer decomposes above 40°C according to the reaction:

$$Ni(CO)_4 \rightarrow Ni + 4\ CO.$$